

**DATA VALIDATION AND STATISTICAL
EVALUATION OF JUNE 2015
GROUNDWATER QUALITY DATA**

CITY OF HELENA LANDFILL

Prepared For:

**CITY OF HELENA
HELENA, MONTANA**



Hydrometrics, Inc.
consulting scientists and engineers

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AUG 31 2015

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Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau



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August 27, 2015

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AUG 31 2015

Mr. John Collins
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Solid Waste Regulatory Program
Montana Department of Environmental Quality
P.O. Box 200901
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Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

RE: Data Validation and Statistical Evaluation of June 2015 Groundwater Quality Data

Dear John,

On behalf of the City of Helena, Hydrometrics validated and statistically evaluated groundwater quality data for samples collected at the City's municipal landfill in June 2015. After receiving approval from Pete Anderson of the City of Helena, I am forwarding a copy of the report "Data Validation and Statistical Evaluation of June 2015 Groundwater Quality Data City of Helena Landfill" for your review.

If you have any questions concerning this report, please don't hesitate to call.

Sincerely,

Jodi Bingham, P.E.
Environmental Engineer/Chemist

Enclosure

- c: Randall Camp, City of Helena, without Enclosure
Pete Anderson, City of Helena, without Enclosure
Mike Wignot, Hydrometrics, without Enclosure

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CITY OF HELENA LANDFILL

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Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

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August 2015

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**DATA VALIDATION AND STATISTICAL
EVALUATION OF JUNE 2015
GROUNDWATER QUALITY DATA
CITY OF HELENA LANDFILL**

1. REPORT OBJECTIVES

This report is prepared on behalf of the City of Helena Landfill to fulfill the groundwater data evaluation requirements provided in Administrative Rules, Montana (ARM) Title 17, Chapter 50. This report provides analytical results for groundwater samples collected at monitoring wells during the June 2015 monitoring event, summarizes, the data validation results, and statistically evaluates the data. The samples were collected and analyzed in accordance with the Montana Department of Environmental Quality (MDEQ) approved sampling and analysis plan (Hydrometrics, 2008).

ARM 17.50.1305(8) and ARM 17.50.1305(9) stipulate the types of statistical data evaluations to be performed on groundwater quality monitoring data from regulated landfills. Federal guidance on conducting statistical evaluations of groundwater data is also available (EPA, 1989; EPA, 1992). These regulations and guidance documents allow the use of a wide range of statistical procedures including: parametric analysis of variance, non-parametric analysis of variance, tolerance or prediction interval testing, trend tests, or other statistical tests meeting the statistical testing objectives of the rules.

Statistical evaluations have been performed for this site semiannually since 1993 and the following conclusions have been reached based on the results of those evaluations:

- Chlorinated hydrocarbons occur downgradient of the landfill;
- Tetrachloroethene (PCE) is the chlorinated organic compound of greatest concern due to Maximum Contaminant Level (MCL) exceedances;

- Concentrations of PCE are decreasing over time in well EPA-1, the well that has historically shown the highest concentrations, and in compliance wells HL-90-1, HL-99-1, and HL-99-3; and
- Elevated nitrate plus nitrite as N (nitrate) concentrations exist both upgradient and downgradient of the landfill, with higher concentrations occurring upgradient.

These findings are further evaluated in this June 2015 statistical report through an assessment of current concentrations (Table 4-1), a comparison of summary statistics (Tables 4-2 and 4-3), an inter-well prediction analysis (Table 4-4), and an examination of temporal trends (Table 4-5 and Figures 4-1 and 4-2).

2.2 WELL LOCATIONS

Structure monitoring wells located around the landfill were included in the June 2015 groundwater monitoring program and are characterized as follows:

- Downgradient wells: HL-90-1, HL-94-1R, HL-94-2R, APC-3,
- Downgradient wells: HL-10-1 (replaced HL-90-1), HL-90-2, HL-90-3, APC-1, APC-2, EPA-1, HL-99-1, HL-99-2, HL-99-3; and
- Upgradient well: HL-94-3.

As discussed in Section 1.0 and in accordance with the approved sampling and analysis plan (Hydrometric, 2008), all locations of these wells were sampled during the June 2015 monitoring event. The locations of these wells are shown in Figure 2-3.

2. SITE DESCRIPTION

2.1 PHYSICAL FEATURES

A site location map is provided in Figure 2-1. The landfill is surrounded for several miles in all directions by residential, commercial, and industrial zoned property. There are several businesses upgradient of the landfill, which have the potential to affect groundwater quality in the area.

A site plan is shown on Figure 2-2. The landfill is divided into three sections. The southern part of the landfill (Phase I and Phase II sections) is unlined and was in operation until the early 1980s. The northern part of the landfill (Phase III) is also unlined, and was in operation until November 1993. The Phase III landfill was capped with an 18-inch clay cover to minimize surface water percolation through the landfill and subsequent migration of chemicals into groundwater. Park improvements completed during 2011 added additional soil cover at varying depth over the majority of the landfill.

2.2 WELL LOCATIONS

Fourteen monitoring wells located around the landfill were included in the June 2015 groundwater monitoring program and are characterized as follows:

- Background wells: HL-06-1, HL-94-1R, HL-94-2R, MPC-5;
- Downgradient wells: HL-10-1 (replaced HL-90-1), HL-90-2, HL-90-3, MPC-1, MPC-2, EPA-1, HL-99-1, HL-99-2, HL-99-3; and
- Cross-gradient well: HL-94-3.

As discussed in Section 3.0 and in accordance with the approved sampling and analysis plan (Hydrometrics, 2008), all fourteen of these wells were sampled during the June sampling event. The locations of these wells are shown in Figure 2-2.



NO SCALE

CITY OF HELENA LANDFILL
DATA VALIDATION & STATISTICAL
EVALUATION OF JUNE 2015
GROUNDWATER QUALITY DATA

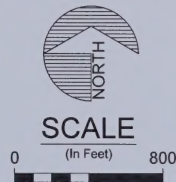
VICINITY MAP

FIGURE

2-1



SITE CODE	DTWL	MPE	SWL
Jun-15			
HL-06-1	16.78	3993.62	3976.84
82-3	66.60	3973.51	3906.91
EPA-1	46.54	3981.08	3934.54
EPA-2	dry	3981.286	
EPA-4	28.98	3973.83	3944.85
HL-10-1	55.64	3943.01	3887.37
HL-90-2	46.39	3950.96	3904.57
HL-90-3	60.22	3958.29	3898.07
HL-94-1R	58.49	3994.04	3935.55
HL-94-2R	33.75	3967.64	3933.89
HL-94-3	35.14	3967.38	3932.24
HL-99-1	60.35	3943.15	3882.80
HL-99-2	89.04	3945.75	3856.71
HL-99-3	64.14	3948.05	3883.91
INF. GALLE	6.73	3918.89	3912.16
I-1	60.21	3899.59	3839.38
MPC-1	22.23	3946.08	3923.85
MPC-2	17.04	3936.09	3919.05
MPC-5	54.67	3990.14	3935.47



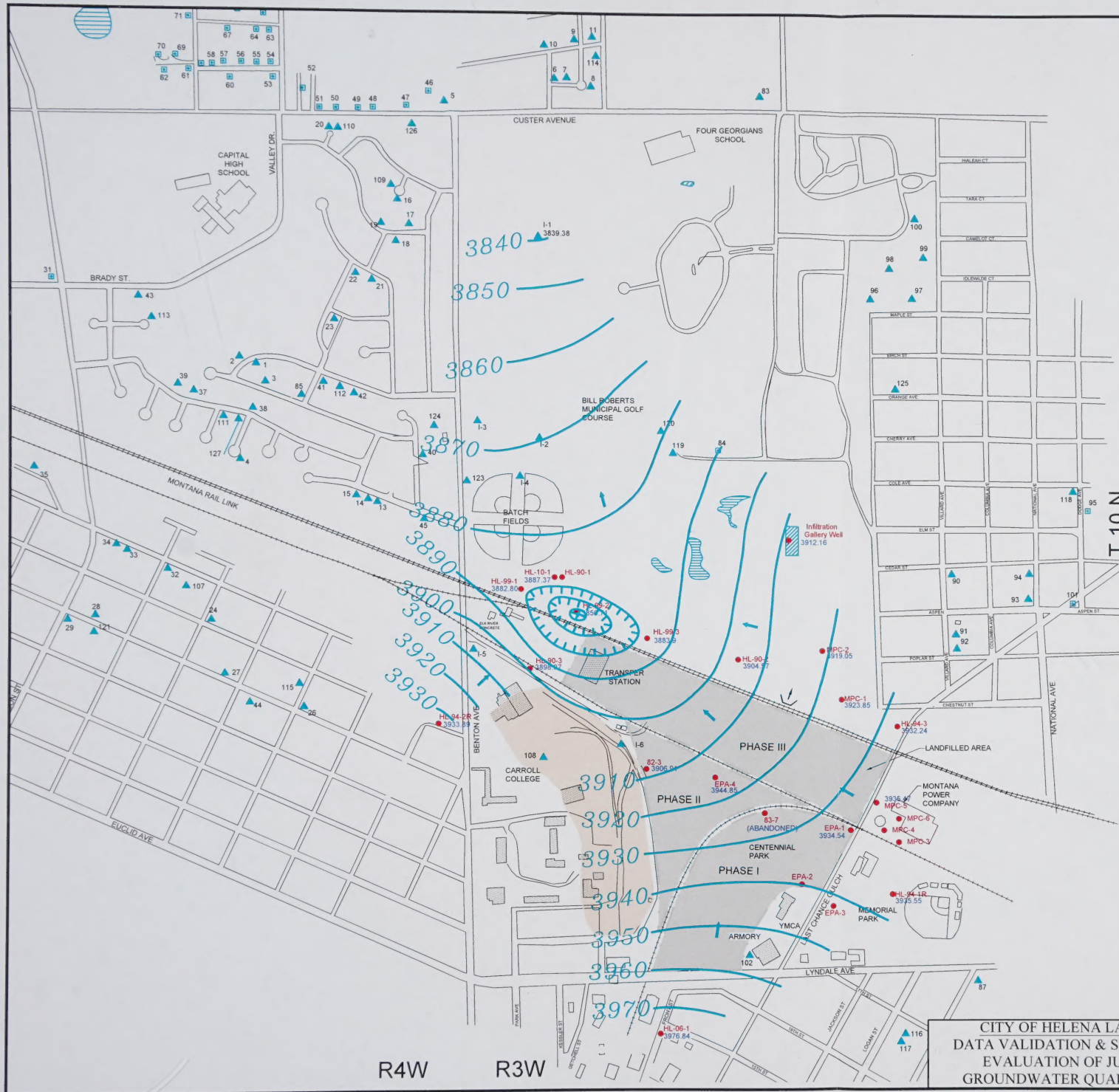
LEGEND

- I-1 ■ PIEZOMETER
- 3-6 ● MONITORING WELL
- I-6 ▲ IRRIGATION WELL
- 80 □ DOMESTIC WELL
- INFILTRATION GALLERY (GROUNDWATER COLLECTION SYSTEM)
- AREA OF SHALLOW LOW PERMEABILITY BEDROCK
- POTENTIOMETRIC CONTOUR LINE
- INFERRED GROUNDWATER FLOW DIRECTION
- STORM WATER OUTFALL FOR LAST CHANCE GULCH

**STUDY AREA AND JUNE 2015
POTENTIOMETRIC SURFACE**

FIGURE

2-2



SITE CODE	DTWL	MPE	SWL
Jun-15			
HL-06-1	16.78	3993.62	3976.84
82-3	66.60	3973.51	3906.91
EPA-1	46.54	3981.08	3934.54
EPA-2	dry	3981.286	
EPA-4	28.98	3973.83	3944.85
HL-10-1	55.64	3943.01	3887.37
HL-90-2	46.39	3950.96	3904.57
HL-90-3	60.22	3958.29	3898.07
HL-94-1R	58.49	3994.04	3935.55
HL-94-2R	33.75	3967.64	3933.89
HL-94-3	35.14	3967.38	3932.24
HL-99-1	60.35	3943.15	3882.80
HL-99-2	89.04	3945.75	3856.71
HL-99-3	64.14	3948.05	3883.91
INF. GALLE	6.73	3918.89	3912.16
I-1	60.21	3899.59	3839.38
MPC-1	22.23	3946.08	3923.85
MPC-2	17.04	3936.09	3919.05
MPC-5	54.67	3990.14	3935.47



LEGEND

- HL-1 ■ PIEZOMETER
- E3-6 ● MONITORING WELL
- I-6 ▲ IRRIGATION WELL
- 80 □ DOMESTIC WELL
- INFILTRATION GALLERY (GROUNDWATER COLLECTION SYSTEM)
- AREA OF SHALLOW LOW PERMEABILITY BEDROCK
- 3900 — POTENTIOMETRIC CONTOUR LINE
- INFERRED GROUNDWATER FLOW DIRECTION
- ↘ STORM WATER OUTFALL FOR LAST CHANCE GULCH

CITY OF HELENA LANDFILL
DATA VALIDATION & STATISTICAL
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GROUNDWATER QUALITY DATA

STUDY AREA AND JUNE 2015
POTENTIOMETRIC SURFACE

FIGURE
2-2

2.3 GROUNDWATER FLOW DIRECTION AND VELOCITY

Figure 2-2 shows water level elevations observed in June 2015 and groundwater potentiometric surface contours. Groundwater flow direction is also shown on this figure. The general groundwater flow direction in the vicinity of the landfill is to the north-northwest. The potentiometric surface in the area of well HL-94-3 suggests that groundwater flows to the west northwest (Figure 2-2); thus, well HL-94-3 is not considered to be upgradient or downgradient of the landfill. Well HL-94-3 has, therefore, been designated as a “cross-gradient” well.

Table 2-1 shows the groundwater velocities calculated for each of the monitoring wells sampled during the June 2015 sampling event. Slope was determined from the potentiometric contours shown in Figure 2-2. The hydraulic conductivities were obtained from the groundwater flow model inputs included in the report “Evaluation of Groundwater Extraction Remediation Alternative at the Helena Landfill” (Hydrometrics, 1999a). The porosity for each well was assumed to be 0.25. An average regional gradient of 0.0229 ft/ft was determined between monitoring well HL-06-1 and I-1. This yields an average regional velocity of 0.678 ft/day.

TABLE 2-1. GROUNDWATER VELOCITIES

Well	Hydraulic Conductivity (ft/day)	Slope (ft/ft)	Velocity (ft/day)
EPA-1	2.8	0.0199	0.223
HL-06-1	0.03	0.0351	0.00421
HL-10-1	20	0.0605	4.84
HL-90-2	5.6	0.0264	0.591
HL-90-3	0.03	0.0596	0.00715
HL-94-1R	2.8	0.0228	0.256
HL-94-2R	0.28	0.0594	0.0665
HL-94-3	2.8	0.0179	0.200
HL-99-1	10	0.0580	2.32
HL-99-2	20	0.00756	0.605
HL-99-3	20	0.0380	3.04
Infiltration Gallery	5.6	0.0248	0.555
MPC-1	2.8	0.0205	0.230
MPC-2	2.8	0.0254	0.285
MPC-5	2.8	0.0206	0.231

3. SUMMARY OF JUNE 2015 DATA VALIDATION REPORT

Fourteen monitoring wells around the landfill, eight domestic wells, one irrigation well, and the infiltration gallery well were included in the June 2015 sampling event. The June 2015 monitoring sites for the City of Helena Landfill include the following:

- Monitoring wells EPA-1, HL-06-1, HL-10-1, HL-90-2, HL-90-3, HL-94-1R, HL-94-2R, HL-94-3, HL-99-1, HL-99-2, HL-99-3, MPC-1, MPC-2, MPC-5;
- Irrigation well I-4;
- Domestic wells 5, 16, 40, 48, 52, 57, 62, 90; and
- The infiltration gallery.

The June analytical parameters included metals, volatile organics, semi-volatile organics, halogenated organics, and major anions for the infiltration gallery and all the monitoring wells except MPC-2. Volatile organics, semi-volatile organics, and halogenated organics were analyzed for samples collected from MPC-2 and all remaining domestic and irrigation wells as specified in the approved sampling and analysis plan (Hydrometrics, 2008).

The water samples collected for the City of Helena Landfill in June 2015 have been validated by the Hydrometrics Data Validation Department in accordance with the project work plan, "Revised Sampling and Analysis Plan, City of Helena Landfill, Groundwater, Surface Water and Landfill Gas Monitoring Activities" (Hydrometrics, 2008). Lab and field quality control procedures were appropriate; quality control (QC) samples included a field duplicate, a D.I. blank, trip blanks, a rinsate blank, and standard internal laboratory QC samples. No parameters were reported as above the reporting limit in the D.I. blank, rinsate blank or trip blanks. In a field duplicate sample, one exceedance occurred for chemical oxygen demand resulting in nine associated results being flagged. The entire data validation report is included as Appendix A of this report. Overall, the City of Helena Landfill data for June 2015 were deemed acceptable for the purposes of the project as outlined in the work plan.

4. STATISTICAL DATA EVALUATION AND COMPARISON

Four types of data evaluations were conducted using the June 2015 sample results for the monitoring wells around the landfill; cross-gradient well HL-94-3 is evaluated separately. The infiltration gallery, irrigation well, and domestic wells are also evaluated separately. The four types of data evaluations conducted are:

1. Comparisons of applicable water quality criteria and upgradient (also called “background”) water quality with summary statistics of downgradient concentrations for June 2015 and all samples to date;
2. Inter-well prediction interval analysis;
3. Trend analysis; and
4. Temporal concentration plots.

The first three analyses include all those parameters for which results were reported above the detection limit in any of the monitoring wells for the June 2015 sampling event. Due to the decrease in laboratory detection limits for many of the parameters, more parameters are included in these tables than historically shown.

The fourth evaluation, temporal concentration plots, was performed for PCE and nitrate; the only constituents that currently exceed their regulatory limits in downgradient wells. Data from all wells sampled during the June 2015 sampling event which have historically shown PCE results above the detection limit and nitrate results above the MCL of 10 mg/L or with potentially increasing trends were evaluated.

4.1 DOWNGRADIENT WATER QUALITY COMPARISONS WITH CRITERIA AND UPGRADIENT WATER QUALITY

The following conclusions are derived from the June 2015 data and summary statistics in Tables 4-1, 4-2, and 4-3:

- (a) For the June 2015 sampling event (Tables 4-1 and 4-2), the following parameters were detected only in background (or upgradient) wells: cadmium, benzene, bromo-

**TABLE 4-1. SUMMARY OF PARAMETER CONCENTRATIONS IN LANDFILL MONITORING WELLS
FOR THE JUNE 2015 MONITORING EVENT**

Parameter	Downgradient Wells									Upgradient Wells				Cross-Gradient	MCL ⁽¹⁾
	HL-90-2	HL-90-3	EPA-1	MPC-1	MPC-2	HL-99-1	HL-99-2	HL-99-3	HL-10-1	HL-06-1	HL-94-1R	HL-94-2R	MPC-5	HL-94-3	
pH (s.u.)	7.6	7.2	6.9	7.2	NM	7.2	7.4	7.3	7.1	7.0	7.4	7.6	7.0	7.6	NA
Specific Conductance (µmhos/cm)	730	1310	2320	1220	NM	1370	876	997	1430	1060	1280	956	2520	1090	NA
Chloride	26	67	164	58	NM	92	42	50	118	47	55	56	28	99	NA
Sulfate	44	180	223	196	NM	166	102	149	161	107	111	56	551	141	NA
Cyanide (Total)	< 0.003	< 0.003	< 0.003	0.02	NM	< 0.003	< 0.003	0.019	< 0.003	< 0.003	< 0.003	< 0.003	0.2	0.005	0.2
Chemical Oxygen Demand (COD)	5	7	15	8	NM	7	7	7	7	3	10	8	69	6	NA
Nitrate+Nitrite as N	1.92	9.3	19.1	14.4	NM	10.9	5.3	8.4	10.0	4.0	20.3	8.0	11.6	18.3	10
Arsenic (Dissolved)	0.002	0.001	< 0.001	0.001	NM	0.002	0.002	0.001	< 0.001	0.002	0.002	0.011	0.003	< 0.001	0.010
Barium (Dissolved)	0.032	0.047	0.078	0.055	NM	0.074	0.044	0.043	0.082	0.047	0.065	0.035	0.036	0.08	1.0
Cadmium (Dissolved)	< 0.00003	< 0.00003	< 0.00003	< 0.00003	NM	< 0.00003	< 0.00003	< 0.00003	< 0.00003	< 0.00003	< 0.00003	< 0.00003	0.00007	< 0.00003	0.005
Copper (Dissolved)	< 0.002	< 0.002	< 0.002	< 0.002	NM	< 0.002	0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	1.3
Iron (Dissolved)	< 0.02	< 0.02	< 0.02	0.03	NM	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.03	0.55	< 0.02	0.3 (2)
Mercury (Dissolved)	< 0.000005	< 0.000005	0.00001	0.000013	NM	0.000028	0.000078	0.000052	0.000066	< 0.000005	< 0.000005	< 0.000005	0.000014	< 0.000005	0.002
Nickel (Dissolved)	< 0.002	< 0.002	0.019	< 0.002	NM	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.009	< 0.002	0.10
Selenium (Dissolved)	< 0.001	0.002	< 0.001	0.002	NM	0.002	< 0.001	< 0.001	< 0.001	0.001	0.008	0.004	0.007	< 0.001	0.05
Benzene	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	4.65	< 0.0005	0.005
Bromodichloromethane	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.0017	< 0.0005	< 0.0005	< 0.0005	0.010
Chloroform	< 0.0005	0.0040	< 0.0005	0.0019	0.00051	0.0016	0.0010	0.0021	0.0006	0.0015	0.013	0.0023	0.013	0.004	0.07
Cis-1,2-Dichloroethene	< 0.0005	< 0.0005	0.0050	0.0089	0.0022	0.0019	0.00071	0.0013	0.0025	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.07
Dichlorodifluoromethane	< 0.0005	< 0.0005	< 0.0005	0.00080	< 0.0005	0.00070	0.0011	0.0013	0.0013	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	1.0
1,1-Dichloroethane	< 0.0005	< 0.0005	< 0.0005	0.0047	0.0020	0.00069	0.0015	0.0034	0.0027	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	NA
Ethylbenzene	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.00083	< 0.0005	0.7
Methylene Chloride	< 0.0005	< 0.0005	< 0.0005	0.00063	< 0.0005	< 0.0005	< 0.0005	0.00062	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.005
Tetrachloroethene (PCE)	< 0.0005	< 0.0005	0.0033	0.0089	0.0028	0.0039	0.0037	0.0072	0.0068	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.005
Toluene	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.015	< 0.0005	1.0
1,1,1-Trichloroethane	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.0014	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.2
Trichloroethene (TCE)	< 0.0005	< 0.0005	< 0.0005	0.0034	0.00096	0.00094	0.00088	0.0015	0.0019	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.005
Trichlorofluoromethane	< 0.0005	< 0.0005	< 0.0005	0.00062	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	10
M+P Xylene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.508	< 0.001	10 (3)
O-Xylene	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.422	< 0.0005	10 (3)
Total Xylene	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.93	< 0.0005	10

Concentrations are in mg/L, except as indicated.

NM = not measured

(1) Primary Maximum Contaminant Levels promulgated under the Safe Drinking Water Act for protection of public drinking water supplies. NA indicates no MCL has been promulgated.

(2) Secondary Maximum Contaminant Level based on aesthetic properties such as taste, odor, and staining.

(3) MCL is for Total Xylenes

Values in bold exceed the MCL.

**TABLE 4-2. COMPARISON OF DOWNGRADIENT CONCENTRATIONS WITH BACKGROUND CONCENTRATIONS
AND MCLs FOR THE JUNE 2015 SAMPLING EVENT**

Parameter	June 2015 Downgradient Well Concentrations (mg/L) ⁽¹⁾						Comparison Values (mg/L)				
	D.F. ⁽³⁾	Min.	Mean ⁽⁴⁾	Median	Max.	Location	Background / Upgradient Wells ⁽²⁾				MCL ⁽⁵⁾
							D.F. ⁽³⁾	Mean ⁽⁴⁾	Median	Max.	
pH (s.u.)	8 / 8	6.9	7.24	7.2	7.6	HL-90-2	4 / 4	7.25	7.2	7.6	NA
Specific Conductance (µmhos/cm)	8 / 8	730	1281.6	1265	2320	EPA-1	4 / 4	1454	1170	2520	NA
Chloride	8 / 8	26	<u>77.1</u>	<u>62.5</u>	164	EPA-1	4 / 4	46.5	51	56	NA
Sulfate	8 / 8	44	152.6	163.5	223	EPA-1	4 / 4	206.3	109	551	NA
Cyanide (Total)	2 / 8	< 0.003	0.0071	< 0.003	0.02	MPC-1	1 / 4	0.05	< 0.003	0.2	0.2
Chemical Oxygen Demand (COD)	8 / 8	5	7.9	7	15	EPA-1	4 / 4	22.5	9	69	NA
Nitrate+Nitrite as N	8 / 8	1.92	9.92	9.65	<u>19.1</u>	EPA-1	4 / 4	<u>10.98</u>	9.8	<u>20.3</u>	10
Arsenic (Dissolved)	6 / 8	< 0.001	0.0014	0.001	0.002	HL-90-2	4 / 4	0.0045	0.0025	<u>0.011</u>	0.010
Barium (Dissolved)	8 / 8	0.032	0.057	0.051	<u>0.082</u>	HL-10-1	4 / 4	0.046	0.0415	0.065	1.0
Cadmium (Dissolved)	0 / 8	< 0.00003	< 0.000030	< 0.00003	< 0.00003	N/A	1 / 4	0.000040	< 0.00003	0.00007	0.005
Copper (Dissolved)	1 / 8	< 0.002	0.0020	< 0.002	0.002	HL-90-2	0 / 4	< 0.0020	< 0.002	< 0.002	1.3
Iron (Dissolved)	1 / 8	< 0.02	0.021	< 0.02	0.03	MPC-1	2 / 4	0.16	0.025	<u>0.55</u>	0.3 (6)
Mercury (Dissolved)	6 / 8	< 0.000005	<u>0.000032</u>	<u>0.000021</u>	<u>0.000078</u>	HL-99-2	1 / 4	0.0000073	< 0.000005	0.000014	0.002
Nickel (Dissolved)	1 / 8	< 0.002	0.0041	< 0.002	0.019	EPA-1	1 / 4	0.0038	< 0.002	0.009	0.10
Selenium (Dissolved)	3 / 8	< 0.001	0.0014	< 0.001	0.0020	HL-90-3	4 / 4	0.0050	0.0055	0.008	0.05
Benzene	0 / 9	< 0.0005	< 0.0005	< 0.0005	< 0.0005	N/A	1 / 4	1.163	< 0.0005	4.65	0.005
Bromodichloromethane	0 / 9	< 0.0005	< 0.0005	< 0.0005	< 0.0005	N/A	1 / 4	0.0008	< 0.0005	0.0017	0.010
Chloroform	7 / 9	< 0.0005	0.0014	0.0010	0.0040	HL-90-3	4 / 4	0.0075	0.0077	0.013	0.07
Cis-1,2-Dichloroethene	7 / 9	< 0.0005	<u>0.0026</u>	<u>0.0019</u>	<u>0.0089</u>	MPC-1	0 / 4	< 0.0005	< 0.0005	< 0.0005	0.07
Dichlorodifluoromethane	5 / 9	< 0.0005	<u>0.00080</u>	0.0007	<u>0.0013</u>	HL-99-3	0 / 4	< 0.0005	< 0.0005	< 0.0005	1
1,1-Dichloroethane	6 / 9	< 0.0005	0.0018	0.0015	0.0047	MPC-1	0 / 4	< 0.0005	< 0.0005	< 0.0005	NA
Ethylbenzene	0 / 9	< 0.0005	< 0.0005	< 0.0005	< 0.0005	N/A	1 / 4	0.0005825	< 0.0005	0.00083	0.7
Methylene Chloride	2 / 9	< 0.0005	<u>0.00053</u>	< 0.0005	<u>0.00063</u>	MPC-1	0 / 4	< 0.0005	< 0.0005	< 0.0005	0.005
Tetrachloroethene (PCE)	7 / 9	< 0.0005	<u>0.0042</u>	<u>0.0037</u>	<u>0.0089</u>	MPC-1	0 / 4	< 0.0005	< 0.0005	< 0.0005	0.005
Toluene	0 / 9	< 0.0005	< 0.00050	< 0.0005	< 0.0005	N/A	1 / 4	0.0041	< 0.0005	0.0150	1.0
1,1,1-Trichloroethane	0 / 9	< 0.0005	< 0.0005	< 0.0005	< 0.0005	N/A	1 / 4	0.00073	< 0.0005	0.0014	0.2
Trichloroethene (TCE)	6 / 9	< 0.0005	0.0012	0.00094	<u>0.0034</u>	MPC-1	0 / 4	< 0.0005	< 0.0005	< 0.0005	0.005
Trichlorofluoromethane	1 / 9	< 0.0005	<u>0.00051</u>	< 0.0005	<u>0.00062</u>	MPC-1	0 / 4	< 0.0005	< 0.0005	< 0.0005	10
M+P Xylene	0 / 9	< 0.001	< 0.001	< 0.001	< 0.001	N/A	1 / 4	0.1278	< 0.001	0.508	10 (7)
O-Xylene	0 / 9	< 0.0005	< 0.0005	< 0.0005	< 0.0005	N/A	1 / 4	0.106	< 0.0005	0.422	10 (7)
Total Xylene	0 / 9	< 0.0005	< 0.0005	< 0.0005	< 0.0005	N/A	1 / 4	0.233	< 0.0005	0.93	10

(1) Downgradient wells are: HL-90-2, HL-90-3, EPA-1, MPC-1, MPC-2, HL-99-1, HL-99-2, HL-99-3, HL-10-1.

(2) Background / Upgradient wells are: HL-06-1, HL-94-1R, HL-94-2R, MPC-5.

(3) Detection frequency (D.F.), i.e. the number of detections over the total number of samples analyzed for that parameter.

(4) Means calculated using the detection limit for non-detected sample results.

(5) Primary Maximum Contaminant Levels promulgated under the Safe Drinking Water Act for protection of public drinking water supplies.
NA indicates no MCL has been promulgated.

(6) Secondary Maximum Contaminant Level based on aesthetic properties such as taste, odor, and staining.

(7) MCL is for Total Xylenes

Values in **bold** exceed the MCL. Underlined values exceed the maximum background/upgradient concentration.

TABLE 4-3. COMPARISON OF DOWNGRADIENT CONCENTRATIONS WITH BACKGROUND CONCENTRATIONS AND MCLs FOR ALL SAMPLING EVENTS TO DATE

Parameter	Period of Record Downgradient Well Concentrations (mg/L) ⁽¹⁾						Comparison Values (mg/L)				
	D.F. ⁽²⁾	Min.	Mean ⁽⁴⁾	Median	Max.	Max. Location	Background / Upgradient Wells ⁽²⁾				MCL ⁽⁵⁾
							D.F. ⁽²⁾	Mean ⁽⁴⁾	Median	Max.	
pH (s.u.)	300 / 300	6.8	7.39	7.4	8.1	HL-90-2	154 / 154	7.42	7.5	8.1	NA
Specific Conductance (µmhos/cm)	290 / 290	632	1090	1020	2550	EPA-1	150 / 150	1398	1020	4170	NA
Chloride	300 / 300	2	60.1	46	262	EPA-1	153 / 154	44.5	29.5	250	NA
Sulfate	299 / 300	< 15	140	139	345	EPA-1	154 / 154	266	100	1980	NA
Cyanide (Total)	88 / 300	< 0.003	0.014	< 0.005	0.40	HL-99-2	36 / 156	1.1	< 0.005	10.9	0.2
Chemical Oxygen Demand (COD)	202 / 298	< 0.3	4.3	3.0	26	EPA-1	127 / 154	13.0	8.0	75	NA
Nitrate+Nitrite as N	277 / 279	< 0.05	7.7	8.22	19.1	EPA-1	149 / 149	10.8	6.9	73	10
Arsenic (Dissolved)	35 / 300	< 0.001	0.0048	< 0.005	0.028	MPC-2	68 / 157	0.0065	< 0.005	0.10	0.010
Barium (Dissolved)	48 / 300	0.032	0.096	< 0.1	0.2	MPC-2	21 / 157	0.094	< 0.1	0.10	1.0
Cadmium (Dissolved)	18 / 303	< 0.00003	0.0010	< 0.001	0.006	HL-90-3	10 / 157	0.00090	< 0.001	0.0020	0.005
Copper (Dissolved)	7 / 283	< 0.002	0.0091	< 0.01	0.01	HL-90-1	6 / 152	0.0092	< 0.01	0.02	1.3
Iron (Dissolved)	70 / 300	< 0.02	0.075	< 0.03	1.69	MPC-1	53 / 154	0.32	< 0.03	3.14	0.3 (6)
Mercury (Dissolved)	27 / 300	< 0.000005	0.00089	< 0.001	0.0010	HL-90-2	7 / 157	0.00089	< 0.001	0.001	0.002
Nickel (Dissolved)	29 / 280	< 0.002	0.010	< 0.01	0.06	EPA-1	29 / 152	0.010	< 0.01	0.050	0.10
Selenium (Dissolved)	20 / 300	< 0.001	0.0046	< 0.005	0.006	HL-90-3	59 / 157	0.0055	< 0.005	0.027	0.05
Benzene	2 / 427	< 0.00005	0.00095	< 0.001	0.0029	HL-90-2	35 / 161	0.052	< 0.001	4.65	0.005
Bromodichloromethane	0 / 427	< 0.0005	< 0.001	< 0.001	< 0.002	NA	19 / 161	0.0012	< 0.001	0.0048	0.010
Chloroform	291 / 427	0.00028	0.0023	0.002	0.016	EPA-1	125 / 161	0.0055	0.0028	0.037	0.07
Cis-1,2-Dichloroethene	135 / 404	< 0.0005	0.0013	< 0.001	0.011	EPA-1	0 / 156	< 0.001	< 0.001	< 0.001	0.07
Dichlorodifluoromethane	185 / 427	0.00047	0.0016	< 0.001	0.016	EPA-1	0 / 161	< 0.001	< 0.001	< 0.001	1
1,1,1-Trichloroethane	265 / 427	< 0.0005	0.0020	0.0014	0.0073	MPC-1	0 / 161	< 0.001	< 0.001	< 0.001	NA
Ethylbenzene	0 / 428	< 0.0005	< 0.001	< 0.001	< 0.001	NA	1 / 161	0.00095	< 0.001	< 0.001	0.7
Methylene Chloride	53 / 427	0.00033	0.0011	< 0.001	0.0078	HL-99-3	2 / 161	0.0010	< 0.001	0.0036	0.005
Tetrachloroethene (PCE)	314 / 427	< 0.0005	0.006441	0.0044	0.094	EPA-1	1 / 161	0.00094	< 0.001	0.0010	0.005
Toluene	16 / 427	< 0.0005	0.0011	< 0.001	0.0094	MPC-2	13 / 161	0.0011	< 0.001	0.015	1.0
1,1,1-Trichloroethane	57 / 427	< 0.0002	0.0011	< 0.001	0.0074	HL-90-1	22 / 161	0.0012	< 0.001	0.0057	0.2
Trichloroethene (TCE)	191 / 427	< 0.0005	0.0013	< 0.001	0.0074	EPA-1	0 / 161	< 0.001	< 0.001	< 0.001	0.005
Trichlorofluoromethane	67 / 427	< 0.0003	0.0011	< 0.001	0.0083	EPA-1	0 / 161	< 0.001	< 0.001	< 0.001	10
M+P Xylene	1 / 399	< 0.001	0.0010	< 0.001	0.002	HL-99-2	33 / 156	0.0062	< 0.001	0.508	10 (7)
O-Xylene	3 / 402	< 0.0005	0.0010	< 0.001	0.002	HL-99-1	35 / 156	0.0086	< 0.001	0.422	10 (7)
Total Xylene	1 / 196	< 0.0005	0.00091	< 0.001	0.002	MPC-2	18 / 81	0.022	< 0.001	0.93	10

(1) Downgradient wells are: HL-10-1, HL-90-1, HL-90-2, HL-90-3, MPC-1, MPC-2, EPA-1, HL-99-1, HL-99-2, HL-99-3.

(2) Background / Upgradient wells are: 83-6, HL-06-1, MPC-5, HL-94-1, HL-94-1R, HL-94-2, HL-94-2R.

(3) Detection frequency (D.F.), i.e. the number of detections over the total number of samples analyzed for that parameter.

(4) Means calculated using the detection limit for non-detected sample results.

(5) Primary Maximum Contaminant Levels promulgated under the Safe Drinking Water Act for protection of public drinking water supplies.

NA indicates no MCL has been promulgated.

(6) Secondary Maximum Contaminant Level based on aesthetic properties such as taste, odor, and staining.

(7) MCL is for Total Xylenes

Values in **bold** exceed the MCL. Underlined values exceed the maximum background/upgradient concentration.

- dichloromethane, ethylbenzene, toluene, 1,1,1-trichloroethane, m+p xylene, o-xylene and total xylene. Parameters detected in only downgradient wells include: copper, cis-1,2-dichloroethene, dichlorodifluoromethane, 1,1-dichloroethane, methylene chloride, tetrachloroethene (PCE), trichloroethene (TCE), and trichlorofluoromethane.
- (b) The parameters historically detected only in background wells (Table 4-3) are bromodichloromethane and ethylbenzene. Parameters historically detected only in downgradient wells include: cis-1,2-dichloroethene, dichlorodifluoromethane, 1,1-dichloroethane, PCE, TCE and trichlorofluoromethane.
- (c) Nitrate, arsenic, iron, benzene, and PCE were reported at concentrations exceeding MCL criteria in the June 2015 sampling event (Tables 4-1 and 4-2). The MCL for benzene was exceeded in a single upgradient well (MPC-5); the MCL for arsenic was exceeded in a single upgradient well (HL-94-2R); the MCL for PCE was exceeded in three downgradient wells (HL-10-1, MPC-1, and HL-99-3); nitrate exceeded its MCL in three downgradient wells (EPA-1, MPC-1, and HL-99-1), two upgradient wells (HL-94-1R and MPC-5), and cross-gradient well HL-94-3; the secondary MCL (based on aesthetic properties rather than human health standards) for iron was exceeded in a single upgradient well (MPC-5).
- (d) Historically in these wells, cyanide, nitrate, arsenic, cadmium, iron, benzene, methylene chloride, PCE, and TCE have been reported at concentrations exceeding MCL criteria (Table 4-3). The MCLs for cadmium, methylene chloride, PCE and TCE have been exceeded in only downgradient wells; cyanide, nitrate, arsenic and iron have exceeded their MCLs in both upgradient and downgradient wells; and the MCL for benzene has been exceeded in only upgradient wells. The June 2015 data is generally consistent with these trends.
- (e) Nitrate was detected in all of the June 2015 samples. The MCL of 10.0 mg/L was exceeded in two samples collected in upgradient wells (HL-94-1R and MPC-5), cross-gradient well HL-94-3, and in three samples collected from downgradient wells (EPA-1, MPC-1, and HL-99-1). Monitoring well MPC-5 showed an increasing trend from 1998 through 2005 reaching a maximum of 73.0 mg/L. Since then, there has been a general decrease in the nitrate concentration in this well and is currently at a level of 11.6 mg/L. Discussions with MPC representatives revealed that an attempt to

remediate cyanide (from a historic coal gasification plant that was operated just east of the landfill) through oxidation may have inadvertently increased nitrate concentration in area groundwater. This pilot program was shut down when these adverse effects became apparent. However, nitrate levels in wells downgradient of the MPC site have slowly been increasing since that time.

- (f) Metals and arsenic concentrations in groundwater samples have historically been low (typically below laboratory detection limits). With the decreased laboratory detection limits, the number of detections has increased both upgradient and downgradient of the landfill. The detected arsenic and metal concentrations were all at or near their detection limits except for arsenic in upgradient well HL-94-2R (0.011 mg/L) compared to a detection limit of 0.001 mg/L, barium in all wells (ranging from 0.032 to 0.082 mg/L) compared to a detection limit of 0.003 mg/L, iron in upgradient well MPC-5 (0.55 mg/L) compared to a detection limit of 0.02 mg/L, and nickel in upgradient well MPC-5 (0.009 mg/L) and downgradient well EPA-1 (0.019 mg/L) compared to a detection limit of 0.002 mg/L. Arsenic exceeded the MCL of 0.01 mg/L in HL-94-2R. Arsenic has historically fluctuated at HL-94-2 with concentrations ranging from <0.005 mg/L to 0.011 mg/L (based on data collected from April 1994 through June 2015). All barium detections are due to a recent reduction in the detection limit and were all well below the MCL of 1.0 mg/L. Iron exceeded the secondary MCL of 0.3 mg/L (based on aesthetic properties such as taste, odor and staining rather than human health standards) in MPC-5. Iron has historically fluctuated at MPC-5 with concentrations ranging from approximately 0.2 mg/L to 4 mg/L (based on data collected from December 1995 through June 2015).
- (g) During the June 2015 sampling event, several volatile organic compounds (VOCs) were detected in samples from downgradient wells, but not in samples from background wells (cis-1,2-dichloroethene, dichlorodifluoromethane, 1,1-dichloroethane, methylene chloride, PCE, TCE, and trichlorofluoromethane). PCE was the only VOC to exceed its MCL in downgradient wells (HL-10-1, MPC-1, and HL-99-3). Benzene, bromodichloromethane, ethylbenzene, toluene, 1,1,1-trichloroethane, m+p xylene, o-xylene, and total xylene were detected only in background wells; benzene was the only VOC to exceed its MCL in upgradient wells

(MPC-5). Chloroform was detected in samples from both downgradient and background wells. All detections of chloroform were well below the MCL of 0.07 mg/L.

- (h) Cyanide was detected in two downgradient wells (MPC-1 and HL-99-3) and one upgradient well (MPC-5) during the June 2015 sampling event. The cyanide MCL of 0.2 mg/L was met but not exceeded in upgradient well MPC-5. Previous sampling events have shown that cyanide is present at concentrations ranging from approximately 0.77 to 11 mg/L (based on data collected from June 1995 through December 2014) in upgradient well MPC-5 and is currently at its lowest concentration in historical record. Historically, downgradient detections of cyanide have been well below the MCL indicating that elevated cyanide levels are not attributable to the Helena Landfill (Table 4-3). As noted previously, a coal gasification plant was historically operated east of the landfill site and could be a source of residual cyanide in groundwater upgradient of the landfill.

4.2 INTER-WELL PREDICTION INTERVAL ANALYSIS

An inter-well prediction interval analysis was used to test for statistically significant differences between background and compliance well concentrations for selected parameters (those above the detection limit in any of the monitoring wells for the June 2015 sampling event). Combining all historical data for the background wells, the Shapiro-Francia Test of Normality was performed for each parameter to determine the distribution of the background data. Inter-well parametric prediction intervals were used when the background data were normally or ln-normally distributed. In cases where the background data were not normally or ln-normally distributed, a non-parametric prediction limit was used. All non-detect values were evaluated at one-half the detection limit. Results of the prediction interval test are summarized in Table 4-4. Documentation for each of these statistical tests used is included in Appendix B of this report.

As shown on Table 4-4, cis-1,2-dichloroethane, dichlorodifluoromethane, 1,1-dichloroethane, PCE, TCE, and trichlorofluoromethane have statistically greater concentrations in downgradient wells than upgradient wells.

TABLE 4-4. RESULTS OF INTER-WELL PREDICTION INTERVAL TESTS

Parameter	Background Wells		Downgradient Wells								
	Distribution ⁽¹⁾	Prediction Limit ⁽²⁾	HL-90-2	HL-90-3	EPA-1	MPC-1	MPC-2	HL-99-1	HL-99-2	HL-99-3	HL-10-1
pH (s.u.)	Non-Norm	6.90 - 7.95	7.6	7.2	6.9	7.2	NM	7.2	7.4	7.3	7.1
Specific Conductance (µmhos/cm)	Non-Norm	3919	730	1310	2320	1220	NM	1370	876	997	1430
Chloride	Non-Norm	182	26	67	164	58	NM	92	42	50	118
Sulfate	Non-Norm	1590	44	180	223	196	NM	166	102	149	161
Cyanide (Total)	Non-Norm	10.5	0.003	0.003	0.003	0.02	NM	0.003	0.003	0.019	0.003
Chemical Oxygen Demand (COD)	Non-Norm	67.4	5	7	15	8	NM	7	7	7	7
Nitrate+Nitrite as N	Non-Norm	62.7	1.92	9.3	19.1	14.4	NM	10.9	5.3	8.4	10
Arsenic (Dissolved)	Non-Norm	0.024	0.002	0.001	0.001	0.001	NM	0.002	0.002	0.001	0.001
Barium (Dissolved)	Non-Norm	0.10	0.032	0.047	0.078	0.055	NM	0.074	0.044	0.043	0.082
Cadmium (Dissolved)	Non-Norm	0.001	0.00003	0.00003	0.00003	0.00003	NM	0.00003	0.00003	0.00003	0.00003
Copper (Dissolved)	Non-Norm	0.015	0.002	0.002	0.002	0.002	NM	0.002	0.002	0.002	0.002
Iron (Dissolved)	Non-Norm	2.84	0.02	0.02	0.02	0.03	NM	0.02	0.02	0.02	0.02
Mercury (Dissolved)	Non-Norm	0.001	0.000005	0.000005	0.00001	0.000013	NM	0.000028	0.000078	0.000052	0.000066
Nickel (Dissolved)	Non-Norm	0.025	0.002	0.002	0.019	0.002	NM	0.002	0.002	0.002	0.002
Selenium (Dissolved)	Non-Norm	0.010	0.001	0.002	0.001	0.002	NM	0.002	0.001	0.001	0.001
Benzene	Non-Norm	0.904	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Bromodichloromethane	Non-Norm	0.0040	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Chloroform	Non-Norm	0.035	0.0005	0.004	0.0005	0.0019	0.00051	0.0016	0.001	0.0021	0.0006
Cis-1,2-Dichloroethene	ND	0.0005	0.0005	0.0005	0.0050	0.0089	0.0022	0.0019	0.00071	0.0013	0.0025
Dichlorodifluoromethane	ND	0.0005	0.0005	0.0005	0.0005	0.0008	0.0005	0.0007	0.0011	0.0013	0.0013
1,1-Dichloroethane	ND	0.0005	0.0005	0.0005	0.0005	0.0047	0.002	0.00069	0.0015	0.0034	0.0027
Ethylbenzene	Non-Norm	0.0010	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Methylene Chloride	Non-Norm	0.0011	0.0005	0.0005	0.0005	0.00063	0.0005	0.0005	0.0005	0.00062	0.0005
Tetrachloroethene (PCE)	Non-Norm	0.0010	0.0005	0.0005	0.0033	0.0089	0.0028	0.0039	0.0037	0.0072	0.0068
Toluene	Non-Norm	0.0044	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
1,1,1-Trichloroethane	Non-Norm	0.0052	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Trichloroethene (TCE)	ND	0.0005	0.0005	0.0005	0.0005	0.0034	0.00096	0.00094	0.00088	0.0015	0.0019
Trichlorofluoromethane	ND	0.0005	0.0005	0.0005	0.0005	0.00062	0.0005	0.0005	0.0005	0.0005	0.0005
M+P Xylene	Non-Norm	0.024	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
O-Xylene	Non-Norm	0.132	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Total Xylene	Non-Norm	0.34	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005

(1) Normality was calculated using the Shapiro-Francia test. (Non-detects replaced with 1/2 detection limit.)

Norm (X%) = data normally distributed at X% level of significance.

In-Norm (X%) = data ln-normally distributed at X% level of significance.

Non-Norm = data not normally or ln-normally distributed at 95% or 99% level of significance.

ND = all background data below detection limits. Value shown is the detection limit.

(2) Inter-well prediction limits calculated as follows with non-detects replaced with 1/2 detection limit:

Normal or ln-normal distribution: parametric prediction interval (99% one-sided, two-sided for pH)

Non-normal distribution: non-parametric prediction interval (99% one-sided, two-sided for pH)

ND: any detectable concentrations in compliance wells are considered significant.

Bold values indicate statistically significant results.

NA - not analyzed

4.3 TREND ANALYSIS

In addition to evaluating the chemical concentrations in upgradient and downgradient wells around the landfill for the June 2015 sampling event, it is also important to evaluate concentration trends of key constituents over time. Using the Mann-Kendall test, statistical testing for trends was performed for each downgradient exceedance of its respective inter-well prediction interval as discussed in Section 4.2. All non-detect values were evaluated as zero to prevent the detection of false trends when parameters are detected at concentrations less than the reporting limit or when the reporting limits have changed over time. The results of these analyses are summarized in Table 4-5. Documentation for these statistical tests is included in Appendix B of this report.

Results show increasing trends in cis-1,2-dichloroethene in well MPC-1, MPC-2, HL-99-2, HL-99-3, and HL-10-1; 1,1-dichloroethane in well HL-99-2; PCE in well MPC-2; and TCE in wells MPC-2, HL-99-2 and HL-10-1. According to National Primary Drinking Water Regulations, cis-1,2-dichloroethane is formed as a breakdown product of the common industrial solvents TCE and PCE. Although there are several wells with increasing trends of cis-1,2-dichloroethane, all detections are well below the MCL of 0.07 mg/L. 1,1-Dichloroethane is a breakdown product of 1,1,1-trichloroethane, historically found primarily in wells upgradient of the Helena landfill. There is no MCL for 1,1-dichloroethane. TCE is an industrial solvent. Although there are several wells with increasing TCE trends, the concentrations of TCE in these wells are all well below the MCL of 0.005 mg/L. Decreasing trends are evident in dichlorodifluoromethane in wells MPC-1, HL-99-1 and HL-99-3; 1,1-dichloroethane in well MPC-1; and PCE in wells EPA-1, HL-99-1 and HL-99-3.

TABLE 4-5. RESULTS OF TREND ANALYSES

Parameter	Downgradient well								
	HL-90-2	HL-90-3	EPA-1	MPC-1	MPC-2	HL-99-1	HL-99-2	HL-99-3	HL-10-1
Cis-1,2-Dichloroethene			No Trend	Increasing	Increasing	No Trend	Increasing	Increasing	Increasing
Dichlorodifluoromethane				Decreasing	Decreasing	Decreasing	No Trend	Decreasing	No Trend
1,1-Dichloroethane				Decreasing	No Trend	No Trend	Increasing	No Trend	No Trend
Tetrachloroethene (PCE)			Decreasing	No Trend	Increasing	Decreasing	No Trend	Decreasing	No Trend
Trichloroethene (TCE)				No Trend	Increasing	No Trend	Increasing	No Trend	Increasing
Trichlorofluoromethane				No Trend					

Mann-Kendall trend analysis with non-transformed data. All non-detects replaced with zero.

Grayed boxes did not have downgradient exceedances of the respective inter-well prediction interval and therefore a trend analysis was not performed.

4.4 TEMPORAL CONCENTRATION PLOTS

This report focuses on concentration trends for PCE and nitrate because they are the only constituents currently exceeding their MCLs in downgradient monitoring wells. PCE was also the focus of the Corrective Measures Assessment for the landfill (Hydrometrics, 1995).

In an attempt to reduce concentrations of PCE in compliance well HL-90-1, the City installed a groundwater extraction system in the spring of 2000 (Hydrometrics, 1999b). This treatment system involves pumping wells HL-99-1, HL-99-2, and HL-99-3 to intercept PCE leaving the landfill, and treating the water to remove VOCs prior to land application on Bill Roberts Golf Course. These wells have been included in groundwater monitoring events along with compliance well HL-90-1, now replaced by HL-10-1, to evaluate the progress of this new groundwater extraction system.

Trends in PCE concentrations over time for the past ten years for selected monitoring wells are shown on Figure 4-1. PCE concentrations exceeded the MCL value of 0.005 mg/L in monitoring wells HL-10-1, MPC-1, and HL-99-3 for June 2015.

Historically, the concentration of PCE in well MPC-1 (now 0.0089 mg/L) has fluctuated between 0.0032 mg/L and 0.017 mg/L based on data collected between May 1992 and December 2014 and according to the trend analysis discussed in the previous section, is neither increasing nor decreasing with time. There is an increasing trend in well MPC-2 beginning in June 2011, but has so far remained below the MCL. The PCE concentrations in pumping wells HL-99-1, HL-99-2, and HL-99-3 have shown seasonal fluctuations and decreasing trends in HL-99-1 and HL-99-3 since their installation in 1999. Concentrations in well EPA-1 have decreased significantly since monitoring began (>90 ppb) and have been below the MCL since December 1999. Compliance well HL-90-1 has shown definite improvement since the installation of the groundwater extraction system in June 2000, averaging 0.0146 mg/L before the extraction system and 0.0071 mg/L after. PCE concentrations in well HL-10-1 (replaced well HL-90-1) have ranged from 0.0060 mg/L to 0.0082 mg/L from June 2010 to the June 2015 sampling event and have shown neither an increasing nor a decreasing trend during statistical analysis.

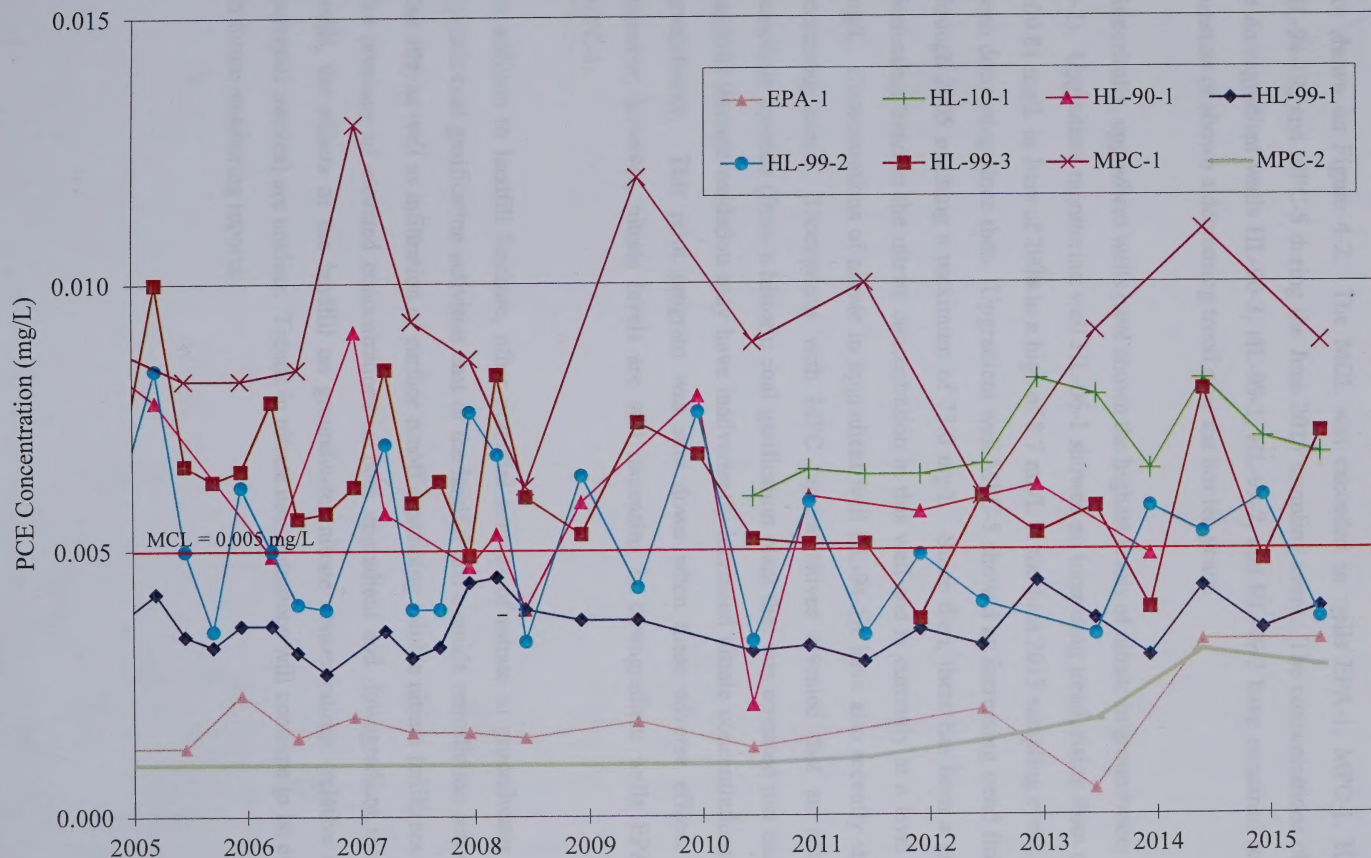


Figure 4-1. Temporal Trends in Tetrachloroethene Concentrations at Selected Monitoring Wells

Trends in nitrate concentrations over time for the last ten years for selected monitoring wells are shown on Figure 4-2. The MCL was exceeded in wells EPA-1, MPC-1, HL-99-1, HL-94-1R, and MPC-5 during the June 2015 sampling event. The concentrations of nitrate in downgradient wells HL-90-3, HL-99-1, HL-99-2, and HL-99-3 have remained relatively constant or shown a decreasing trend over the last ten years.

Historically, upgradient wells have shown the highest levels of nitrate in groundwater (Figure 4-2). Upgradient monitoring well HL-06-1 showed an increasing trend, rising from a low of 0.81 mg/L in June of 2008 to a high of 8.7 mg/L in the June 2013 sampling event, but has been decreasing since then. Upgradient well MPC-5 showed an increasing trend from 1998 through 2005 reaching a maximum of 73.0 mg/L. Since then, there has been a generally decreasing trend in the nitrate concentration in this well and is currently at a level of 11.6 mg/L. Concentrations of nitrate in upgradient well HL-94-1R have also recently shown an increasing trend. Discussions with MPC representatives revealed that an attempt to remediate cyanide (from a historic coal gasification plant that was operated just east of the landfill) through oxidation may have inadvertently increased nitrate concentrations in area groundwater. This pilot program was shut down when these adverse effects became apparent; however, nitrate levels are still increasing in downgradient wells EPA-1 and MPC-1.

In addition to landfill leachate, other potential sources of nitrate in groundwater include historic coal gasification activities east of the landfill and cyanide remediation activities for this site, as well as infiltration of surface runoff containing soluble nitrate fertilizers. Due to the presence of elevated concentrations in both upgradient and downgradient monitoring wells, the effects of the landfill on groundwater nitrate concentrations (relative to other potential sources) are unclear. Trends in nitrate concentrations will continue to be evaluated in future monitoring reports.

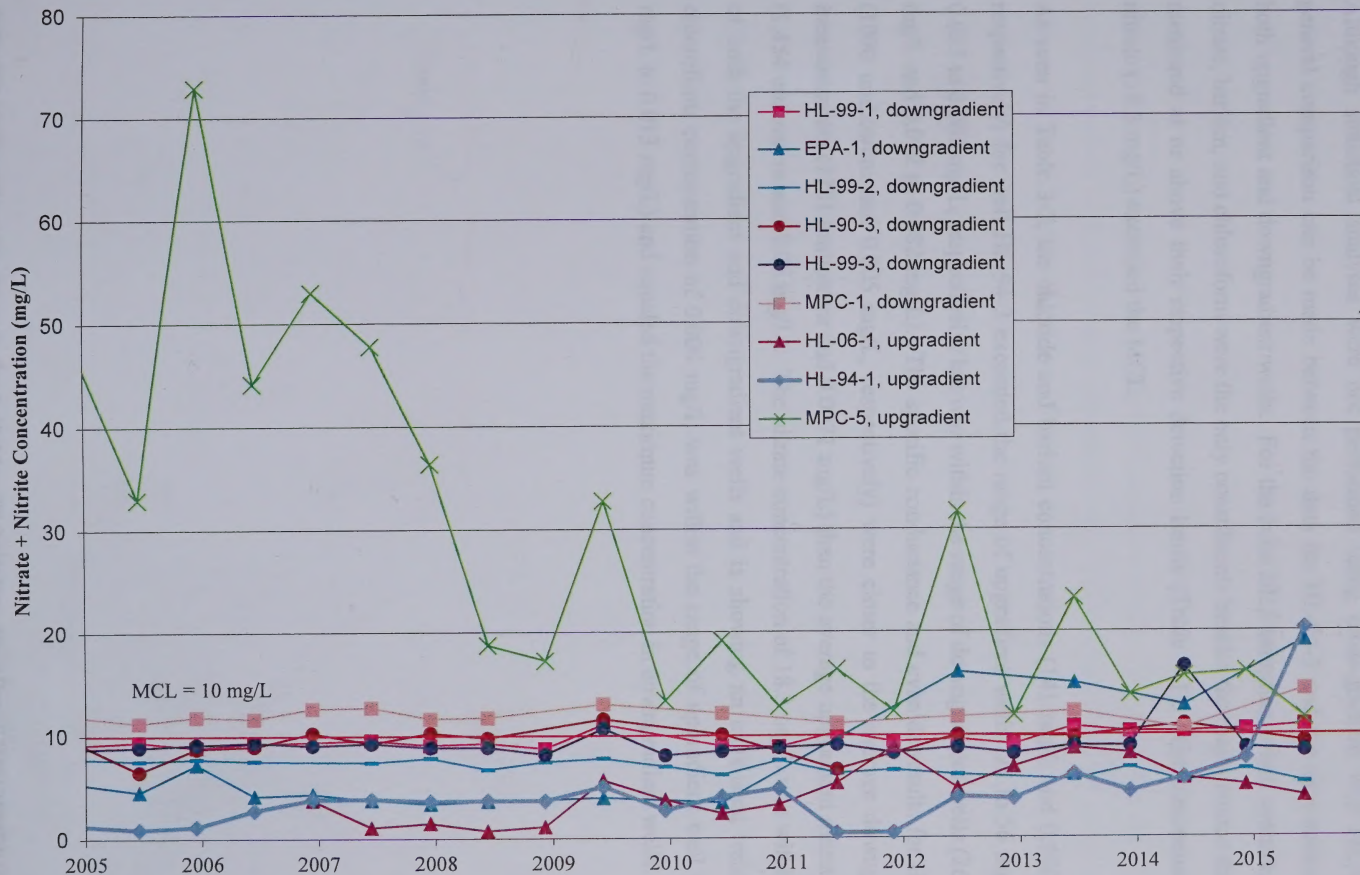


Figure 4-2. Temporal Trends in Nitrate Concentrations at Selected Monitoring Wells

4.5 CROSS-GRADIENT DATA EVALUATION

Although statistical analyses were not performed using cross-gradient well HL-94-3, a general comparison can be made between the data for HL-94-3 and the data collected for both upgradient and downgradient wells. For the June 2015 sampling event, cyanide, COD, nitrate, barium, and chloroform were the only constituents besides the major anions that were measured at or above their respective detection limits (Table 4-1). The concentration of nitrate (18.3 mg/L) exceeded the MCL.

As seen in Table 3-2, the chloride and barium concentrations (141 mg/L and 0.080 mg/L, respectively) for well HL-94-3 exceeded the range of upgradient wells (28 to 56 mg/L and 0.035 to 0.065 mg/L, respectively) but was within the range of downgradient wells (26 to 164 mg/L and 0.032 to 0.082 mg/L). The specific conductance and cyanide results for HL-94-3 (1090 umhos/cm and 0.005 mg/L, respectively) were closer to the average downgradient measurements (1281 umhos/cm and 0.0071 mg/L) than the average upgradient measurement (1,454 umhos/cm and 0.05 mg/L). The nitrate concentration of 18.3 mg/L was within range of both the upgradient and downgradient wells and is showing an increasing trend. The chloroform concentration of 0.004 mg/L was within the range of upgradient well (0.0015 mg/L to 0.013 mg/L) and equaled the maximum concentration in downgradient wells.

5. IRRIGATION WELL AND DOMESTIC WELL DATA EVALUATION

One irrigation well (I-4), the infiltration gallery and eight domestic wells (5, 16, 40, 48, 52, 57, 62, and 90) were also sampled during the June 2015 sampling event. Due to the lower laboratory detection limits, more VOC constituents were detected than historically. The infiltration gallery had no VOCs reported above the detection limits. All other wells in this group contained detectable concentrations of chloroform. All of the domestic wells with the exception of well 62 had detectable concentrations of PCE. Wells 5 and I-4 had detectable concentrations of 1,1-dichloroethane. Wells 52, 57 and I-4 had detectable concentrations of dichlorodifluoromethane. Wells 40 and I-4 had detectable concentrations of cis-1,2-dichloroethene and wells 5 and I-4 had detectable concentrations of TCE. All detections of VOCs were below their respective MCLs.

Trends in PCE concentrations over the last ten years for the sampled domestic and irrigation wells are shown on Figure 5-1. Most of these wells are showing generally decreasing trends with time. Well 16 shows a slight increasing PCE trend but remains well below the MCL. All of these wells are used only for irrigation and all homeowners of these domestic wells have been connected to the City water supply.

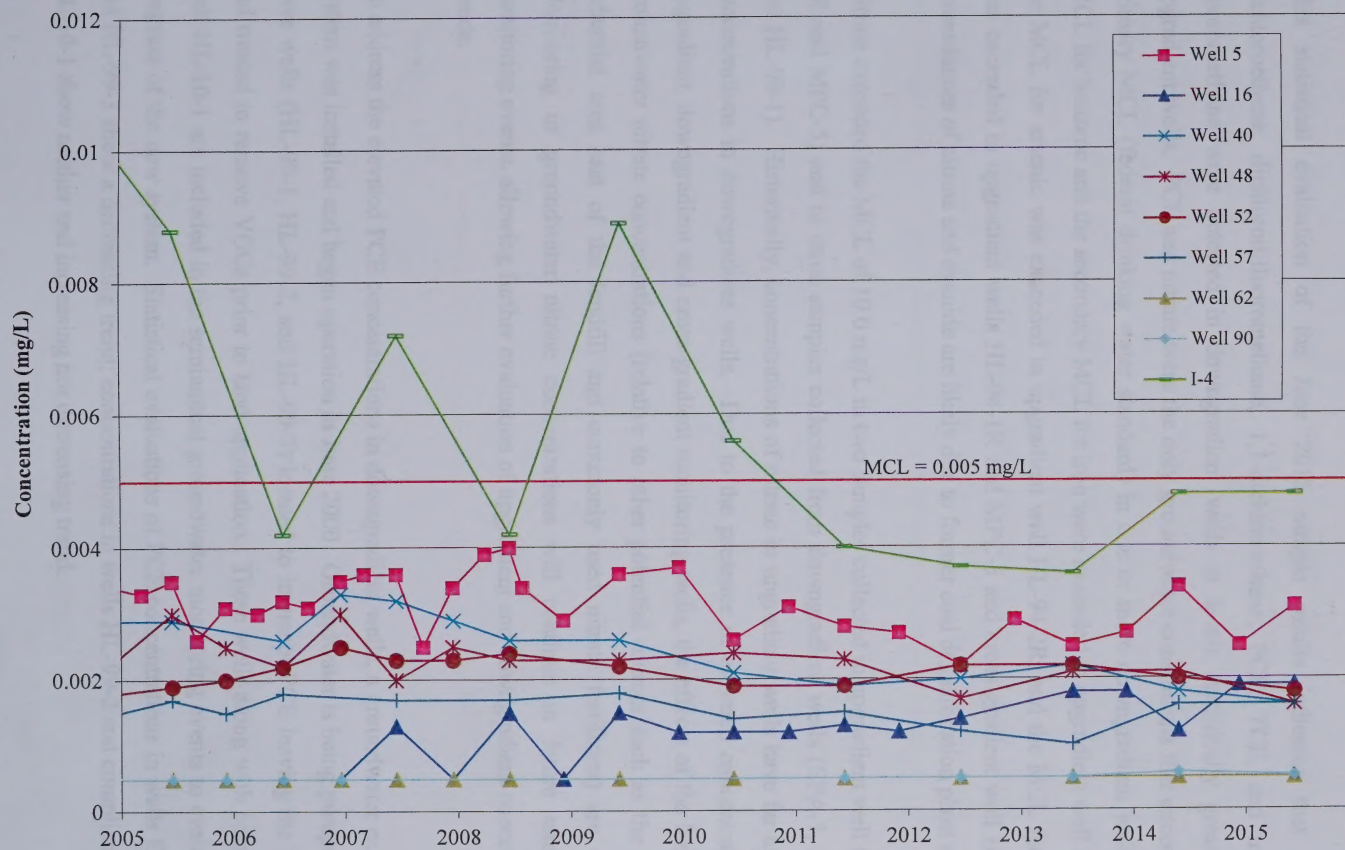


Figure 5-1. Temporal Trends in PCE Concentrations in Domestic and Irrigation Wells

6. SUMMARY AND CONCLUSIONS

This statistical evaluation of the June 2015 sample results indicated that cis-1,2-dichloroethene, dichlorodifluoromethane, 1,1-dichloroethane, PCE, TCE, and trichlorofluoromethane were detected in downgradient wells at levels statistically greater than upgradient wells. PCE and nitrate were the only groundwater constituents that exceeded the primary MCL (federal drinking water standard) in one or more downgradient wells. The MCL for benzene and the secondary MCL for iron were exceeded in upgradient well MPC-5; the MCL for arsenic was exceeded in upgradient well HL-94-2R; and the MCL for nitrate was exceeded in upgradient wells HL-94-1R and MPC-5 and cross-gradient well HL-94-3. Exceedances of nitrate and cyanide are likely due to former coal degasification plant sources.

Nitrate exceeded the MCL of 10.0 mg/L in two samples collected in upgradient well (HL-94-1R and MPC-5) and in three samples collected from downgradient wells (EPA-1, MPC-1, and HL-99-1). Historically, concentrations of nitrate in upgradient wells have far exceeded concentrations in downgradient wells. Due to the presence of elevated concentrations in upgradient, downgradient and cross-gradient monitoring wells, the effects of the landfill on groundwater nitrate concentrations (relative to other potential sources such as the historic industrial area east of the landfill and commonly used nitrate fertilizers) are unclear. Monitoring of groundwater nitrate concentrations will continue in future semiannual monitoring events, allowing further evaluation of upgradient and downgradient concentration trends.

To address the elevated PCE concentrations in downgradient wells, a groundwater extraction system was installed and began operation in June 2000. Groundwater is being pumped from three wells (HL-99-1, HL-99-2, and HL-99-3) located to intercept PCE leaving the landfill, and treated to remove VOCs prior to land application. These wells along with compliance well HL-10-1 are included in the semiannual groundwater monitoring events to evaluate the progress of the new system. Statistical evaluations of PCE concentrations in wells HL-99-1 and HL-99-3 show a decreasing trend; concentrations in wells HL-99-2 and compliance well HL-10-1 show neither an increasing nor decreasing trend.

PCE exceeded the federal MCL in downgradient wells MPC-1, HL-99-3, and HL-10-1. According to the potentiometric map in Figure 2-2, groundwater flow through well MPC-1 generally heads towards the groundwater extraction well where it can be extracted and treated. Concentrations of PCE in extraction wells HL-99-1 and HL-99-3 show a statistically decreasing trend. Well HL-10-1 was installed in May 2010 immediately adjacent to but deeper than compliance well HL-90-1. The concentration of PCE in well HL-10-1 is within historical range of HL-90-1 concentrations and near the MCL (0.0068 mg/L compared to the MCL of 0.005 mg/L). It is predicted that PCE concentrations in HL-10-1 should continue to be stable or decrease as assumed finite upgradient sources are diminished. Downgradient of HL-10-1, irrigation well I-4 and domestic wells 5, 40, 48, and 57 also show generally decreasing trends since the installation of the groundwater extraction system.

7. REFERENCES

- EPA, 1989. Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities - Interim Final Guidance, PB89-151047, February 1989.
- EPA, 1992. Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities - Addendum to Interim Final Guidance, Draft, Office of Solid Waste, Permits and State Programs Division, July 1992.
- Hydrometrics, Inc., 1995. Corrective Measures Assessment, City of Helena Landfill, Helena, Montana, Prepared for City of Helena, February 1995.
- Hydrometrics, Inc., 1999a. Evaluation of Groundwater Extraction Remediation Alternative at the Helena Landfill, Prepared for the City of Helena, August 1999.
- Hydrometrics, Inc., 1999b. Contract Documents and Specifications for Helena Landfill Groundwater Extraction City, City of Helena Project No. 99-15, Prepared for City of Helena, September 1999.
- Hydrometrics, Inc., 2008. Revised Sampling and Analysis Plan, City of Helena Landfill, Groundwater, Surface Water and Landfill Gas Monitoring Activities, Prepared for City of Helena, March 2008.

DATA VALIDATION REPORT
CITY OF ANCHORAGE, ALASKA

Groundwater Sampling Location(s)
June 2015
Data Review Period(s)

APPENDIX A

DATA VALIDATION REPORT

Project ID
Hydrographer's Name
City/County/State
Date(s) for Data

DATA VALIDATION REPORT
CITY OF HELENA LANDFILL

Groundwater Samples Collected in

June 2015

(Semi-Annual Sampling)

Prepared by
Hydrometrics, Inc.
3020 Bozeman Avenue
Helena, MT 59601

JULY 2015

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GLOSSARY OF TERMS

CCB	Continuing Calibration Blank
CCV	Continuing Calibration Verification
CLP	Contract Laboratory Program
CRDL.....	Contract Required Detection Limit
FAA	Flame Atomic Absorption
GFAA	Graphite Furnace Atomic Absorption
HGAA.....	Hydride Generation Atomic Absorption
ICB.....	Initial Calibration Blank
ICP	Inductively Coupled Plasma
ICV	Initial Calibration Verification
IDL.....	Instrument Detection Limit
LCS.....	Laboratory Control Sample
MSA.....	Method of Standard Additions
PB	Preparation Blank
PRDL	Project Required Detection Limit
QAPP	Quality Assurance Project Plan
QC.....	Quality Control
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
SOW	Statement of Work
TDS.....	Total Dissolved Solids

SUMMARY

Laboratory analysis for groundwater samples collected for the June 2015 sampling event as part of the City of Helena Landfill have been reviewed and validated. This review has been in accordance with the "Revised Sampling and Analysis Plan; City of Helena Landfill; Groundwater, Surface Water, and Landfill Gas Monitoring Activities" (Hydrometrics, March 2008). All samples were analyzed at Energy Laboratories in Helena, Montana.

Data results are qualified when associated field quality control samples have not met validation criteria. Not all quality control deficiencies are equally serious and some may not have any practical impact on the usefulness of the data. A summary of quality control violations found in this validation follows:

Violations involving field quality control samples:

- In field duplicate samples, HL-1506-108/109 (HL-90-3); one exceedance occurred for chemical oxygen demand resulting in nine associated results being flagged.
- It should be noted that the wells were not sampled in the order listed in the SAP. The order of sampling was followed for all wells that do not use dedicated or disposable equipment. Any variances in sampling order were noted in the field book or sampling forms.

Violations involving laboratory quality control samples:

- In the QA/QC Summary Reports provided by Energy Laboratories, there were several QA/QC exceedances. However, at this level of validation, laboratory exceedances are noted but no flagging of the data occurs.
- It should be noted that the reporting limits used for all metals analysis varied from the requested limits however the RLs used were lower than the requested limits, and did not seem to impact the results of the analysis.
- It should be noted that Energy Laboratories used a different method than stated in the work plan on the following parameters: pH, SC, cyanide and all dissolved metals. However, no associated data was flagged because the methods used are considered comparable to stated methods in the work plan.
- Energy Laboratories exceeded the holding time for pH for all samples submitted. However, as a rule holding times for laboratory pH measurements are frequently exceeded because measurements are typically not conducted "immediately", but rather as soon as practicable. Therefore, no qualifiers are applied for lab pH holding time exceedances.

DATA VALIDATION REPORT

Deviations from the prescribed quality control procedures and/or exceedances of quality control limits have been noted, and results have been flagged in the database. The data quality objectives for accuracy and precision were met, as 99 percent of the field quality control sample results were within control limits and 98 percent of the laboratory quality control samples were within limits. The frequency requirements of 10 percent submittal of blanks, duplicates, control standards and spikes were met. The recommended project completeness goal, acceptance of 90 percent of the results as valid, has also been met as no results have been rejected as a result of this review. Further discussion of data quality objectives is in Section 12 of the data validation report. All tables are in Appendix 1: data validation codes and definitions are listed in Table 1; and a historical comparison is in Table 2; and a summary of flagged data is in Table 3. A database printout of this sampling event is located in Appendix 2. The Hydrometrics field Notes are in Appendix 3. Energy Laboratories Analytical Reports are located in Appendix 4.

Sample ID	Sample Name	Sample Type	Sample Date	Sample Time	Sample Location	Sample Status	Sample Results	Sample Comments
101	101-100-101							
102	102-100-102							
103	103-100-103							
104	104-100-104							
105	105-100-105							
106	106-100-106							
107	107-100-107							
108	108-100-108							
109	109-100-109							
110	110-100-110							
111	111-100-111							
112	112-100-112							
113	113-100-113							
114	114-100-114							
115	115-100-115							
116	116-100-116							
117	117-100-117							
118	118-100-118							
119	119-100-119							
120	120-100-120							
121	121-100-121							
122	122-100-122							
123	123-100-123							
124	124-100-124							
125	125-100-125							
126	126-100-126							
127	127-100-127							
128	128-100-128							
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131	131-100-131							
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141	141-100-141							
142	142-100-142							
143	143-100-143							
144	144-100-144							
145	145-100-145							
146	146-100-146							
147	147-100-147							
148	148-100-148							
149	149-100-149							
150	150-100-150							

1. Blank parameters include pH, DO, and water temperature.
2. Results are marked as "Valid" if they are within the control limits of the data quality objectives.
3. Results are marked as "Invalid" if they are outside the control limits of the data quality objectives.

DATA VALIDATION REPORT

1. INTRODUCTION

This validation applies to organic and inorganic analyses for 33 water samples collected for the City of Helena Landfill semi-annual monitoring project during the June 2015 sampling event. The total number of samples included: one field duplicate, two field blanks (DI and Rinsate), two trip blanks, twenty-four non-QC water samples and four field observations.

All samples were submitted for volatile organic analyses, and select samples were submitted for inorganic analyses (metals and wet chemistry) as follows:

SITE CODE	SAMPLE NUMBER	WATER LEVEL	FIELD PARAMETERS ¹	METALS AND COMMONS ²	VOLATILES METHOD 8260 ³
INF GALLERY	AEH-1506-102	X	X		X
MPC-2	AEH-1506-103	X	X		X
#90	AEH-1506-126		X		X
Rinsate Blank	AEH-1506-125		X	X	X
D.I. Blank	AEH-1506-124		X	X	X
MPC-5	AEH-1506-123	X	X	X	X
#52	AEH-1506-119		X		X
I-4	AEH-1506-115		X		X
#5	AEH-1506-100		X		X
HL-99-1	AEH-1506-111	X	X	X	X
HL-90-2	AEH-1506-104	X	X	X	X
HL-06-1	AEH-1506-107	X	X	X	X
HL-90-3	AEH-1506-108	X	X	X	X
HL-90-3 DUP	AEH-1506-109			X	X
HL-94-1R	AEH-1506-105	X	X	X	X
HL-94-2R	AEH-1506-110	X	X	X	X
HL-94-3	AEH-1506-106	X	X	X	X
EPA-2	AEH-1506-130	X			
#57	AEH-1506-120	X	X		X
EPA-4	AEH-1506-129	X			
MPC-1	AEH-1506-116	X	X	X	X
EPA-1	AEH-1506-117	X	X	X	X
#62	AEH-1506-121		X		X
#48	AEH-1506-122		X		X
HL-10-01	AEH-1506-114	X	X	X	X
#16	AEH-1506-101		X		X
HL-99-3	AEH-1506-113	X	X	X	X
#40	AEH-1506-118		X		X
TRIP BLANK	TB 4862				X
TRIP BLANK	TB 4862				X
HL-99-2	AEH-1506-112	X	X	X	X
I-1	AEH-1506-127	X			
82-3	AEH-1506-128	X			

1.) Field parameters include pH, SC, and water temperature.

2.) Metals and commons include those compounds listed in the first half of ARM 17.50.708 Table 1.

3.) Volatile organic compounds include those listed in the second half of ARM 17.50.708 Table 1.

- Validation procedures used are generally consistent with:

(Check all that apply)

- ☒ EPA CLP National Functional Guidelines for Inorganics Data Review
- ☒ EPA CLP National Functional Guidelines for Organic Data Review
- ☒ Work Plan (Sampling and Analysis Plan, City of Helena Landfill Groundwater Monitoring Activities, Hydrometrics, March 2008)

- Overall level of validation:

- ☐ Contract Laboratory Program (CLP)
- ☒ Standard (see following Notes)
- ☐ Visual

Notes: The review of this data includes checking all field and laboratory quality control samples; flagging for exceedances in field quality control; and calculating precision, accuracy, and completeness for both laboratory and field quality control samples.

2. DELIVERABLES

- All laboratory document deliverables were present as specified in the CLP-Statement of Work (CLP-SOW), EPA, 1993 and/or the project contract.

☒ Yes (see following notes)
☐ No

- All documentation of field procedures was provided as required.

☒ Yes
☐ No

- Consistency with project requirements

Sampling was completed in order as stated in the SAP.

☒ Yes (see following Notes)
☐ No

Notes: It should be noted that the wells were not sampled in the order listed in the SAP. The order of sampling was followed for all wells that do not use dedicated or disposable equipment. Any variances in sampling order were noted in the field book.

3. FIELD QUALITY CONTROL SAMPLES

- Field blanks

Please note that the highest blank value associated with any particular analyte is the blank value used for the flagging process.

DI, trip, rinsate, or any other field blanks have been carried out at the proper frequency.

☒ Yes
☐ No

Reported results on the field blanks are less than the contract required detection limits (CRDL) or the project required detection limits (PRDL) if project detection limits have been specified.

☒ Yes
☐ No

- **Field duplicates**

Field duplicates have been collected at the proper frequency.

☒ Yes

☐ No

Field duplicate relative percent differences (RPD's) were within the required control limits (RPD of 20 percent or less for water matrix, 35 percent or less for soil matrix). If the sample or duplicate result is less than 5 times the PRDL, the RPD criteria are not used. In these cases, the difference between the sample and the duplicate results must be within $\pm$ the PRDL for water matrix, within $\pm$ 2 times the PRDL for soil matrix.

☐ Yes

☒ No (see the following notes)

Notes: In field duplicate samples, HL-1506-108/109 (HL-90-3); one exceedance occurred for chemical oxygen demand resulting in nine associated results being flagged.

- **Field standards**

Field standards were sent at the proper frequency

☐ Yes

☐ No

☒ NA - Not required by the work plan.

4. LABORATORY PROCEDURES

- **Laboratory procedures followed**

☐ CLP-SOW

☒ SW-846

☒ Methods for Chemical Analysis of Water and Wastes

☐ XRF Standard Operating Procedures

☐ Other

- **Samples were received by the laboratory at the proper temperature**

☒ Yes

☐ No

- **Holding times met**

☐ Yes

☒ No (see the following Notes)

Notes: Energy Laboratories exceeded the holding time for pH for all samples submitted. However, as a rule holding times for laboratory pH measurements are frequently exceeded because measurements are typically not conducted "immediately", but rather as soon as practicable. Therefore, no qualifiers are applied for lab pH holding time exceedances in the database.

- **Consistency with project requirements**

Analyses were carried out as requested.

☒ Yes (see following Notes)

☐ No

Project specified methods were used.

☒ Yes (see following Notes)

☐ No

Notes: Energy Laboratories used a different method than stated in the work plan on the following parameters: pH, SC, cyanide and all dissolved metals. However, no associated data was flagged because the methods used are considered comparable to stated methods in the work plan.

5. DETECTION LIMITS

- Reporting detection limits met project required detection limits (PRDL).

☒ Yes (see following Notes)

☐ No

Notes: The reporting limits used for all metals analysis varied from the requested limits however the RLs used were lower than the requested limits, and did not seem to impact the results of the analysis.

6. LABORATORY BLANKS

Please note that the highest blank value associated with any particular analyte is the blank value used for the flagging process.

- Preparation/Method blanks

Preparation/Method blanks were prepared and analyzed at the required frequency.

☒ Yes

☐ No

All analytes in the preparation blank were less than the CRDL (or PRDL if a project detection limit has been specified).

☒ Yes

☐ No

7. LABORATORY BLANK SPIKES

- Blank Spikes

Blank spikes (organics) were prepared and analyzed at the required frequency.

☒ Yes

☐ No

Blank spike recoveries were within control limits.

☒ Yes

☐ No

8. SURROGATE SPIKES

Surrogate spikes were prepared and analyzed at the required frequency.

☒ Yes

☐ No

Surrogate spike recoveries were within control limits.

☒ Yes

☐ No

9. MATRIX SPIKE /MATRIX SPIKE DUPLICATES (MS/MSD)

- Matrix spike samples were analyzed at the proper frequency.

☒ Yes

☐ No

Matrix spike recoveries were within control limits.

☐ Yes

☒ No (see following Notes)

Notes: Several matrix spike and matrix spike duplicate samples contained QC exceedances. At this level of validation, these exceedances are only noted and no associated data is qualified.

- Matrix spike duplicate samples were analyzed at the proper frequency.

☒ Yes

☐ No

Matrix spike duplicate RPD's were within control limits.

☐ Yes

☒ No (see following Notes)

Notes: Several matrix spike and matrix spike duplicate samples contained QC exceedances. At this level of validation, these exceedances are only noted and no associated data is qualified.

10. INTERPARAMETER RELATIONSHIPS

- The following relationships have been checked for all data from the June 2015 monitoring:

☒ Lab SC versus field SC

☒ Lab pH versus field pH

Lab SC versus field SC: A comparison of the field and lab SCs using a percent difference (%D) criteria for evaluation purposes. For this data set, the data were all found to be within acceptable limits.

Lab pH versus field pH: A comparison of the field and lab pHs using a percent difference (%D) criteria for evaluation purposes. For this data set, the data were all found to be within acceptable limits.

11. HISTORICAL COMPARISON

Current sampling event data (June 2015) were compared to historical data. The data for the June 2015 sampling event compared well to the historic data.

12. DATA QUALITY OBJECTIVES

- Project data quality objectives (DQO's) met.

☒ Yes

☐ No

Accuracy

Accuracy for this project is the agreement between a measured value and a true value and is measured by the recoveries on the laboratory matrix spikes and laboratory control samples.

Accuracy for this sampling event was 98 percent.

Precision

Precision for this project is the degree of variability between duplicate measurements. Laboratory analytical variability is measured by laboratory duplicates; field duplicates are a measure of overall variability in both field sampling and laboratory techniques.

Laboratory precision was 98 percent for this sampling event.

Field precision was 99 percent for this sampling event.

Completeness

The target completeness for this project is 90 percent of the measurements valid (not rejected). This percentage is based on the number of valid measurements compared to the number of planned measurements. Completeness for this sampling event was 100 percent.

DATA VALIDATION REPORT

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Reviewed by: Jodi Bingham, P.E.

REFERENCES

- Hem, J.D., 1992. Study and Interpretation of the Chemical Characteristics of Natural Water, 3rd Edition. US Geological Survey Water Supply Paper 2254.
- Hydrometrics Project Work Plan. Sampling and Analysis Plan City of Helena Landfill Groundwater Monitoring Activities, March 2008.
- U.S. Environmental Protection Agency, 1990. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition.
- U.S. Environmental Protection Agency, 1993. USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review. October 2004.
- U.S. Environmental Protection Agency, 1994. USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review. October 2004.

APPENDIX B

STATISTICAL ANALYSIS REPORTS

Validation and Statistical
Evaluation of June 2015
Groundwater Quality Data

City of Helena Landfill
Appendix B - Statistical Analysis Reports

August 2015

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